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Aquatic Invertebrate Monitoring at Hot Springs National Park, 2009

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Stream at Hot Springs National Park
Heartland Inventory and Monitoring Network file photo

Aquatic Invertebrate Monitoring at Hot Springs National Park, 2009

Natural Resource Report NPS/HTLN/NRDS—2012/241

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Contents

Tables

Abstract

The National Park Service began monitoring water quality and invertebrate community structure in Bull Bayou and Gulpha Creek at Hot Springs National Park in June 2009. A Surber stream bottom sampler was used to collect 9 benthic samples from each stream. Habitat data were collected from the sampling net frame, and water quality data were recorded hourly using a data logger. This report summarizes the baseline aquatic invertebrate monitoring data. There presently are insufficient aquatic invertebrate data to fully characterize the integrity of Bull Bayou and Gulpha Creek, but preliminary indications based on a comparison to regional least disturbed streams suggests they may be mildly impaired. Samples were dominated by pollution tolerant taxa, but both streams had some pollution intolerant taxa present. Mean Hilsenhoff Biotic Index (HBI) levels were moderate for both streams. Ephemeroptera, Plecoptera, Trichoptera (EPT) ratios were relatively high for both streams, indicating low Chironomidae density in both streams, particularly in Gulpha Creek. All measured water quality parameters were within Arkansas surface water standards. Because the headwater sources of Bull Bayou and Gulpha Creek are located outside the park boundary, there are some potential threats to the watersheds of both streams. Continued assessment of long term water quality conditions, aquatic biota, and land use will provide park managers with information on the developing impacts in the upstream basins of Bull Bayou and Gulpha Creek.

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Introduction

Aquatic invertebrates are an important biological assessment tool for understanding and detecting changes in stream ecosystem integrity. They can be used to reflect cumulative impacts that cannot otherwise be detected through traditional water quality monitoring. The National Park Service began monitoring water quality and invertebrate community structure in Bull Bayou and Gulpha Creek at Hot Springs National Park (HOSP) in 2009 following the guidance of Bowles et al. (2008). Both streams flow through HOSP, but their headwater sources are located outside park boundaries, making them susceptible to anthropogenic disturbances. Gulpha Creek and Bull Bayou have relatively small drainage areas with greater than 95% forested areas in their drainage basins (Petersen and Mott 2002). Little is known about the water quality of Gulpha Creek and Bull Bayou within the park. In addition, there are few available data for least-disturbed streams in the Ouachita Mountains ecoregion that can be used to compare invertebrate community structure (Galloway et al. 2008). Least-disturbed, or reference streams contain high-quality stream reaches that are representative of the best possible stream condition. No previous studies of stream invertebrate community structure at HOSP have been conducted.

The monitoring objectives of this study, as described by DeBacker et al. (2005), are: 1) determine the status and trends of invertebrate species diversity, abundance, and community metrics, and 2) relate the invertebrate community to overall water quality through quantification of metrics related to species richness, abundance, diversity, and region-specific multi-metric indices as indicators of water quality and habitat condition. The purpose of this report is to summarize baseline aquatic invertebrate monitoring data collected during June 2009 under the framework of the small steams monitoring protocol (Bowles et al. 2008).

Methods

Methods and procedures used in this report follow Bowles et al. (2008). Samples were collected at one 150 m reach of Gulpha Creek and at one 150 m reach of Bull Bayou on June 16, 2009 (Fig. 1). Three successive riffles were sampled, with three benthic invertebrate samples collected at each riffle, resulting in nine total samples for each stream. A Surber stream bottom sampler (500 μm mesh, 0.09 m^2) was used to collect samples with substrate agitated by a handheld garden cultivation tool. Samples were sorted in the laboratory following a subsampling routine described in Bowles et al. (2008). Taxa were identified to the lowest practical taxonomic level (usually genus) and counted. Metrics calculated for each sample included taxa richness, Shannon diversity index, EPT (Ephemeroptera, Plecoptera, Trichoptera) richness, EPT ratio [EPT density/(EPT density + Chironomidae density)], Shannon evenness (where 0 = minimum evenness, 1 = maximum evenness), and the Hilsenhoff Biotic Index (HBI). For details on calculating and interpreting metrics used in this report refer to Bowles et al. (2008). Higher metric values are associated with better stream conditions, except for HBI where smaller values indicate better conditions. An increase in HBI is undesired because that would reflect increasing tolerance of the community to disturbance.

For each sample, current velocity (meters/second) and depth (cm) were recorded directly in front of the sampling net frame. Qualitative habitat variables (embeddedness, periphyton, filamentous algae, aquatic vegetation, deposition, and organic material) were estimated within the sampling

net frame as percentage categories (0, <10, 10-40, 40-75, >75). Habitat data were analyzed as midpoints of each category. Dominant substrate size from the area within the sampling net frame was visually assessed using the Wentworth scale (Wentworth 1922). Stream discharge was measured upstream of the sample site for both streams. Water quality readings were recorded hourly using a calibrated YSI 6920 or YSI 6600 data logger for approximately 40 hours.

The water quality and habitat data presented in this report represent only a snapshot of the broad temporal range of conditions. They are intended to describe the prevailing conditions that influence the structure of invertebrate communities, and they may help explain variability between samples, but they should not be used as an analytical tool in the strictest sense (Bowles et al. 2008). Due to the limitations of using water quality data obtained with data loggers, the invertebrate community is used here as a surrogate of the long-term water quality condition of Gulpha Creek and Bull Bayou.

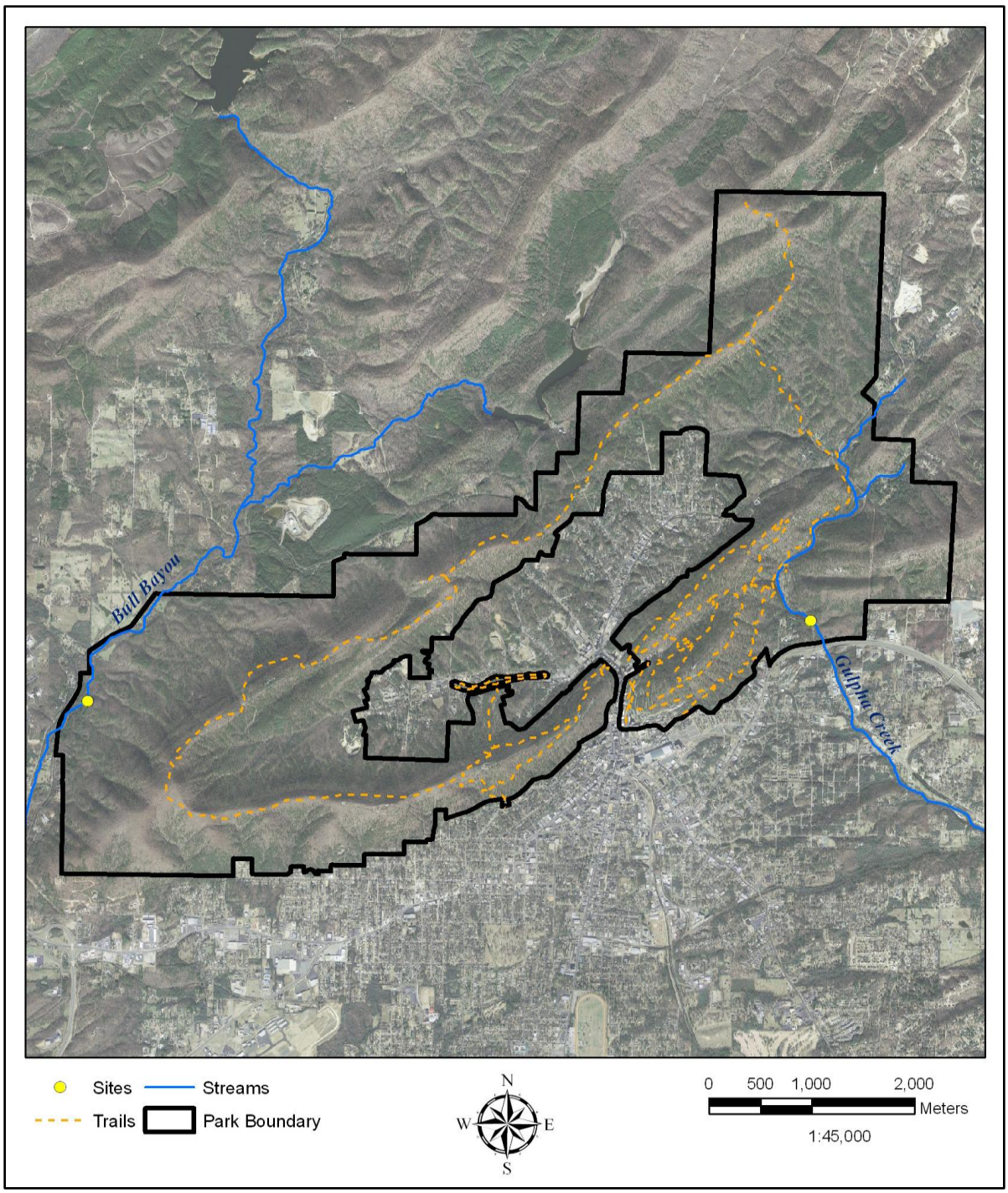

Figure 1. Map showing the approximate lower sampling reach for Gulpha Creek and Bull Bayou, Hot Springs National Park.

Results

Metric and diversity values reported here generally did not meet those previously reported for least-disturbed Ouachita Mountains ecoregion streams during a spring index period (Galloway et al. 2008, ADEQ 2010, Table 1). Mean taxa richness was 18.1 in Bull Bayou and 14.4 in Gulpha Creek , but EPT richness was similar for both streams (7.6 and 8.1, respectively) (Tables 2 and 3). EPT ratios were high for both streams (Bull Bayou mean 0.83, range= 0.63 - 0.93; Gulpha Creek mean 0.92, range= 0.84 – 1.00) indicating that Chironomidae did not represent a substantial portion of the benthic community among samples in either stream. The mean percentage composition of Chironomidae for Bull Bayou was 11% and 5% for Gulpha Creek.

Shannon's Index values for Bull Bayou and Gulpha Creek were 2.15 and 2.03, respectively (Tables 2 and 3). The Shannon Index accounts for both abundance and evenness of the species present and index values are higher when all taxa in a sample are equally abundant or have high evenness. For biological data, values of Shannon's index typically range from 1.5 (low species richness and evenness) to 3.5 (high species evenness and richness). Mean Shannon evenness for Bull Bayou was 0.73 (range= 0.64 - 0.83) and 0.76 (range= 0.63 - 0.87) for Gulpha Creek (Tables 2 and 3). Evenness increases as the index approaches 1.

Samples from Bull Bayou and Gulpha Creek contained both pollution tolerant and intolerant taxa. This is reflected in the moderate HBI values for each stream (Tables 2 and 3). Mean HBI for Bull Bayou was 5.86 (range= 5.3 - 6.16) while that of Gulpha Creek was 5.1 (range= 4.17 - 6.06). Tolerance values range from 0-10 with values of 0-3 classified as intolerant and values from 7-10 as tolerant (Barbour et al. 1999). Because HBI scores can range from 0 to 10, the moderate HBI scores for both creeks indicate the water quality condition for both streams is fair. Among all samples in Bull Bayou, the three dominant taxa were pollution tolerant, with tolerance values greater than 6. Dominant taxa included the caddisfly (Trichoptera) genus *Cheumatopsyche* (Hydropsychidae), the mayfly (Ephemeroptera) genus *Caenis* (Caenidae), and the dipteran family Chironomidae. The tolerant isopod genus *Lirceus* (Crustacea) was also secondarily dominant in Bull Bayou (Appendix A). Although the dominant taxa had high tolerance values, approximately 12% of the sample in Bull Bayou was represented by intolerant taxa (Appendix A). Among samples in Gulpha Creek, the two most dominant taxa were *Cheumatopsyche* and *Caenis*, both with higher tolerance values. The mayfly family Baetidae (Ephemeroptera) was also dominant in Gulpha Creek, with tolerance values of 4 or less. Approximately 26% of the sample in Gulpha Creek was intolerant taxa (Appendix A).

All water quality parameters measured in this study were well within the Arkansas surface water standards (Tables 4-6). Mean specific conductance was lower in Bull Bayou than Gulpha Creek, but did not exceed 124 µS/cm in any instance. Specific conductance values between 100-400 µS/cm are generally considered favorable for supporting stream life. Mean dissolved oxygen also was slightly higher in Bull Bayou than Gulpha Creek (8.7 and 7.9 mg/l, respectively). Stream discharge for Bull Bayou was 0.1 m^3/s and 0.05 m^3/s for Gulpha Creek.

Habitat among riffles in both streams was generally uniform (Tables 7 and 8). Both streams were shallow (mean riffle depth ≤12.33 cm), with slow current velocities (mean ≤0.5 m/s). Substrate was consistent in size and consisted mainly of large pebbles. Mean substrate size in Bull Bayou was 60.94 mm (range= 56.57 - 69.60 mm) and 47.77 mm (range=28.37 - 71.1 mm) in Gulpha

Creek. Mean substrate embeddedness was low for both streams at 25% for both streams. Mean deposition for Bull Bayou was 18.33% and 22.78% for Gulpha Creek. Among biological parameters measured, mean periphyton was 22.78% for Bull Bayou (range= 18.33 - 25.00%). Periphyton was lower in Gulpha Creek (mean = 6.67%, range=3.33 - 11.67%). No aquatic vegetation or filamentous algae were found in Gulpha Creek while Bull Bayou had a small amount of aquatic vegetation (mean=0.56%) and no filamentous algae. Percent organic material was low and uniform among samples (mean=5%) for both streams.

Table 1. Benthic invertebrate metric data for least-disturbed Ouachita Mountains ecoregion streams during a spring index period (from Galloway et al. 2008).

Statistic	Taxa Richness	EPT Richness	HBI
Minimum	16	10	3.35
25th percentile	19.5	11	3.71
Mean	21.5	12.3	3.92
75th percentile	23	14	4.24
Maximum	28	14	4.54

Table 2. Summary statistics for invertebrate samples collected from Bull Bayou, Hot Springs National Park, 2009.

Statistic	Taxa Richness	EPT Richness	EPT Ratio	Shannon's Index	Shannon's Evenness	HBI
Mean	18.11	7.56	0.83	2.15	0.73	5.86
Standard Error	1.48	0.75	0.03	0.11	0.02	0.09
Minimum	8.00	5.00	0.63	1.46	0.64	5.30
Maximum	23.00	12.00	0.93	2.51	0.83	6.16
N	9.	9	9	9	9	9

Table 3. Summary statistics for invertebrate samples collected from Gulpha Creek, Hot Springs National Park, 2009.

Statistic	Taxa Richness	EPT Richness	EPT Ratio	Shannon's Index	Shannon's Evenness	HBI
Mean	14.44	8.11	0.92	2.03	0.76	5.10
Standard Error	1.58	0.68	0.02	0.13	0.03	0.22
Minimum	7.00	5.00	0.84	1.32	0.63	4.17
Maximum	23.00	11.00	1.00	2.52	0.87	6.06
N	9	9	9	9	9	9

Table 4. Water quality data for Bull Bayou, Hot Springs National Park, 2009. Data were collected hourly with calibrated data loggers.

Statistic	Temperature (^{o}C)	Specific Conductance (µS/cm)	Dissolved Oxygen (mg/L)	pH	Turbidity (NTU)
Mean	24.14	60.55	8.70	6.95	1.18
Median	23.99	61.00	8.55	6.93	1.20
Standard Deviation	1.26	0.76	0.41	0.09	0.34
Minimum	22.38	59.00	8.26	6.78	0.90
Maximum	26.40	62.00	9.47	7.23	3.10
Count	39.00	38.00	39.00	39.00	39.00

Table 5. Water quality standards for surface waters in the Ouachita Mountains, from Arkansas Pollution Control and Ecology Commission, 2010.

Parameter	Water Quality Standard
Temperature (^{o}C)	Not to exceed 30^{o}C
Dissolved Oxygen (mg/L)	Bull Bayou: not less than 6 mg/L primary; 6 mg/L critical Gulpha Creek: not less than 6 mg/L; primary 2 mg/L critical
pH	6.0 to 9.0; not to change >1.0 unit in 24 hours
Turbidity (NTU)	10 NTU base flow; 18 NTU all flow
Specific Conductance	N/A

Table 6. Water quality data for Gulpha Creek, Hot Springs National Park, 2009. Data were collected hourly with calibrated data loggers.

Statistic	Temperature (^{o}C)	Specific Conductance (µS/cm)	Dissolved Oxygen (mg/L)	pH	Turbidity (NTU)
Mean	24.05	119.31	7.91	7.69	0.64
Median	24.02	120.00	7.89	7.66	0.60
Standard Deviation	0.97	2.95	0.17	0.07	0.13
Minimum	22.61	114.00	7.65	7.62	0.40
Maximum	25.73	124.00	8.20	7.87	1.00
Count	42.00	42.00	42.00	42.00	42.00

Table 7. Summary statistics for habitat variables associated with benthic samples collected from Bull Bayou, Hot Springs National Park, 2009.

Habitat Parameter	Mean	Standard Error	Minimum	Maximum	Count
Depth (cm)	12.33	2.01	10.00	16.33	3
Velocity (m/s)	0.50	0.11	0.32	0.70	3
Embeddedness (%)	25.00	0.00	25.00	25.00	3
Vegetation (%)	0.56	0.56	0.00	1.67	3
Filamentous Algae (%)	0.00	0.00	0.00	0.00	3
Periphyton (%)	22.78	2.22	18.33	25.00	3
Deposition (%)	18.33	3.85	11.67	25.00	3
Organics (%)	5.00	0.00	5.00	5.00	3
Substrate (Wentworth scale)	60.94	4.28	56.67	69.50	3

Table 8. Summary statistics for habitat variables associated with benthic samples collected from Gulpha Creek, Hot Springs National Park, 2009.

Habitat Parameter	Mean	Standard Error	Minimum	Maximum	Count
Depth (cm)	9.44	1.24	7.00	11.00	3
Velocity (m/s)	0.24	0.03	0.20	0.30	3
Embeddedness (%)	25.00	0.00	25.00	25.00	3
Vegetation (%)	0.00	0.00	0.00	0.00	3
Filamentous Algae (%)	0.00	0.00	0.00	0.00	3
Periphyton (%)	6.67	2.55	3.33	11.67	3
Deposition (%)	22.78	2.22	18.33	25.00	3
Organics (%)	5.00	0.00	5.00	5.00	3
Substrate (mm)	47.77	12.49	28.37	71.10	3

Discussion

The data presented in this report are insufficient to fully characterize the integrity of Bull Bayou and Gulpha Creek. In comparison to least disturbed streams in the Ouachita Mountain Ecoregion, preliminary data for both streams indicate they may be mildly impaired. Potential sources of contamination include a landfill in the upper watershed of Bull Bayou, and urbanization and other land use practices in the Gulpha Creek watershed (e.g., golf course, lawn care, pest management, fuel storage and commercial activities) (Petersen and Mott 2002). There are few available options to park management for mitigating water quality impairment of streams flowing through HOSP, largely because impacts to water quality and associated effects on the invertebrate communities originate upstream of the park boundaries. Impacts of urbanization on streams often are so pervasive that mitigation strategies are difficult and rarely fully effective (Bernhardt et al. 2005, Paul et al. 2009).

Maintaining and widening of riparian buffer zones along these streams in the park will aid in protecting aquatic life as well as in-stream habitat from local chemical runoff and sedimentation. Riparian buffers can be improved by restoring native vegetation to areas where they occurred historically. Improved buffer zones will reduce bank erosion within HOSP by reducing stream velocity and the amount of water entering the streams. A reduction in impervious surfaces (sidewalks, parking lots) within the park would also help to stabilize the riparian zone and in-stream habitat. Continued assessment of long term water quality conditions achieved through monitoring aquatic invertebrate community structure serves as a useful tool for providing park managers information on the impacts of anthropogenic disturbances in the Bull Bayou and Gulpha Creek watersheds.

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Appendix. Aquatic invertebrate data collected from Hot Springs National Park (HOSP), 2009.

Table A-1. Aquatic invertebrate data collected from Bull Bayou, HOSP, 2009. TV= tolerance value. Sample numbers are for riffles (1-3) and samples taken at left, middle, and right channel.

Phylum	Class	Order	Family	Genus	Samples										
					TV	1L	1M	1R	2L	2M	2R	3L	3M	3R	Total
Annelida	Oligochaeta				8	3	6	8		1	2	1			**21**
Arthropoda	Arachnoida	Hydracarina			5.7			1				1			**2**
Arthropoda	Crustacea	Decapoda	Cambaridae		6	1	1		1	2	1		1	2	**9**
Arthropoda	Crustacea	Isopoda	Asellidae	*Lirceus*	7.7	13	10	34	12	2	16		1	17	**105**
Arthropoda	Insecta	Coleoptera	Elmidae	*Optioservus*	2.7	2	7	6		1	1		2	3	**22**
Arthropoda	Insecta	Coleoptera	Elmidae	*Stenelmis*	5.4	6		2	2	3	1		22	12	**48**
Arthropoda	Insecta	Coleoptera	Psephenidae	*Psephenus*	2.5	6	1	7	12	1	2		5	2	**36**
Arthropoda	Insecta	Collembola							2	2	2				**6**
Arthropoda	Insecta	Diptera	Chironomidae		6	36	16	11	28	2	7	20	30	23	**173**
Arthropoda	Insecta	Diptera	Empididae	*Hemerodromia*	6	3	1		1		1				**6**
Arthropoda	Insecta	Diptera	Simuliidae	*Prosimulium*	2.6						1				**1**
Arthropoda	Insecta	Diptera	Simuliidae	*Simulium*	4.4	1			22			2	38	2	**65**
Arthropoda	Insecta	Diptera	Tipulidae	*Antocha*	4.6		1				1			1	**3**
Arthropoda	Insecta	Diptera	Tipulidae	*Tipula*	7.7					1	1		1	1	**4**
Arthropoda	Insecta	Ephemeroptera	Baetidae	*Acentrella*	3.6	1						1	1		**3**
Arthropoda	Insecta	Ephemeroptera	Baetidae	*Acerpenna*	3.7	7	11	1	1	3					**23**
Arthropoda	Insecta	Ephemeroptera	Baetidae		4	5	13	6	12	6	10		7	3	**62**
Arthropoda	Insecta	Ephemeroptera	Caenidae	*Caenis*	7.6	34	44	29	49	9	39	5	7	24	**240**
Arthropoda	Insecta	Ephemeroptera	Heptageniidae		4	9	7	2	3	1	6				**28**
Arthropoda	Insecta	Ephemeroptera	Heptageniidae	*Stenacron*	7.1		8	7		2	12				**29**

Table A-1. Continued.

Phylum	Class	Order	Family	Genus	TV	Samples									
						1L	1M	1R	2L	2M	2R	3L	3M	3R	Total
Arthropoda	Insecta	Ephemeroptera	Heptageniidae	*Stenonema*	3.4	7	2	4	7	2		1		1	**24**
Arthropoda	Insecta	Ephemeroptera	Isonychiidae	*Isonychia*	3.7	2									**2**
Arthropoda	Insecta	Ephemeroptera	Leptophlebiidae	*Leptophlebia*	6.4	1									**1**
Arthropoda	Insecta	Megaloptera	Corydalidae	*Corydalus*	5.6				1			1	1		**3**
Arthropoda	Insecta	Megaloptera	Corydalidae	*Nigronia*	5.8		1						1		**2**
Arthropoda	Insecta	Odonata	Gomphidae		7		1								**1**
Arthropoda	Insecta	Plecoptera			2	3		1	1						**5**
Arthropoda	Insecta	Plecoptera	Perlidae		1					1	1				**2**
Arthropoda	Insecta	Plecoptera	Perlidae	*Neoperla*	1.6	4	9	3	10	3	7	4	20	11	**71**
Arthropoda	Insecta	Trichoptera	Helicopsychidae	*Helicopsyche*	0	2	1	3	1						**7**
Arthropoda	Insecta	Trichoptera	Hydropsychidae	*Cheumatopsyche*	6.6	60	28	12	106	48	8	23	92	86	**463**
Arthropoda	Insecta	Trichoptera	Philopotamidae	*Chimarra*	2.8	12	3		7				14	9	**45**
Arthropoda	Insecta	Trichoptera	Polycentropodidae	*Polycentropus*	3.5	3	2	2							**7**
Mollusca	Bivalvia	Veneroidea	Corbiculidae	*Corbicula*	6.3	1							2	1	**4**
Mollusca	Gastropoda	Neotaenioglossa	Pleuroceridae	*Elimia*	2.5		2	3	1				1	3	**10**
Mollusca	Gastropoda				7		1								**1**
Platyhelminthes	Turbellaria	Tricladida	Planariidae	*Dugesia*	7.5				3						**3**
Total						**223**	**176**	**142**	**282**	**90**	**121**	**59**	**248**	**202**	

Table A-2. Aquatic invertebrate data collected from Gulpha Creek, HOSP, 2009. TV= tolerance value. Sample numbers are for riffles (1-3) and samples taken at left, middle, and right channel.

						Samples									
Phylum	**Class**	**Order**	**Family**	**Genus**	**TV**	**1L**	**1M**	**1R**	**2L**	**2M**	**2R**	**3L**	**3M**	**3R**	**Total**
Annelida	Oligochaeta				8	2	1	2		1				1	**7**
Arthropoda	Arachnoida	Hydracarina			5.7								1		**1**
Arthropoda	Crustacea	Amphipoda	Hyalellidae	*Hyalella*	7.9									1	**1**
Arthropoda	Crustacea	Decapoda	Cambaridae		6		2	1			1		1	1	**6**
Arthropoda	Crustacea	Isopoda	Asellidae	*Lirceus*	7.7	1	1				1		1		**4**
Arthropoda	Insecta	Coleoptera			0		1								**1**
Arthropoda	Insecta	Coleoptera	Elmidae	*Optioservus*	2.7	1									**1**
Arthropoda	Insecta	Coleoptera	Elmidae	*Stenelmis*	5.4		1		3	1				2	**7**
Arthropoda	Insecta	Coleoptera	Psephenidae	*Psephenus*	2.5	3	4		6	4	1				**18**
Arthropoda	Insecta	Collembola				1			1						**2**
Arthropoda	Insecta	Diptera	Ceratopogonidae		6		2			1					**3**
Arthropoda	Insecta	Diptera	Chironomidae		6		6	4	10	23	10	1	1	4	**59**
Arthropoda	Insecta	Diptera	Simuliidae	*Simulium*	4.4				4	40	6				**50**
Arthropoda	Insecta	Ephemeroptera	Baetidae		4	7	31	6	7	17	11	4	4	14	**101**
Arthropoda	Insecta	Ephemeroptera	Baetidae	*Acentrella*	3.6	12	19		15	43	8	1	1	3	**102**
Arthropoda	Insecta	Ephemeroptera	Baetidae	*Acerpenna*	3.7			1					1		**2**
Arthropoda	Insecta	Ephemeroptera	Baetidae	*Baetis*	6									2	**2**
Arthropoda	Insecta	Ephemeroptera	Baetidae	*Pseudocloeon*	4.4		8				1				**9**
Arthropoda	Insecta	Ephemeroptera	Caenidae	*Caenis*	7.6	51	52	4	28	42	73	22	13	62	**347**
Arthropoda	Insecta	Ephemeroptera	Heptageniidae		4	2	3				10		1	3	**19**

Table A-2. Continued.

Phylum	Class	Order	Family	Genus	TV	Samples									
						1L	1M	1R	2L	2M	2R	3L	3M	3R	Total
Arthropoda	Insecta	Ephemeroptera	Heptageniidae	*Stenacron*	7.1	3	1				2			2	**8**
Arthropoda	Insecta	Ephemeroptera	Heptageniidae	*Stenonema*	3.4		4	2		3	1		1		**11**
Arthropoda	Insecta	Lepidoptera								1	1				**2**
Arthropoda	Insecta	Megaloptera	Corydalidae	*Corydalus*	5.6		1								**1**
Arthropoda	Insecta	Odonata	Gomphidae		7		1				4				**5**
Arthropoda	Insecta	Plecoptera			2	4		2	7	10	47	3		6	**79**
Arthropoda	Insecta	Plecoptera	Perlidae		1		1								**1**
Arthropoda	Insecta	Plecoptera	Perlidae	*Neoperla*	1.6	3	13	2	6	11	11	1	5	1	**53**
Arthropoda	Insecta	Trichoptera	Helicopsychidae	*Helicopsyche*	0	1	1							4	**6**
Arthropoda	Insecta	Trichoptera	Hydropsychidae	*Cheumatopsyche*	6.6	14	20	2	7	71	14	1	1	5	**135**
Arthropoda	Insecta	Trichoptera	Hydropsychidae	*Hydropsyche*	4					2					**2**
Arthropoda	Insecta	Trichoptera	Philopotamidae	*Chimarra*	2.8	2	14			14	8				**38**
Arthropoda	Insecta	Trichoptera	Polycentropodidae	*Polycentropus*	3.5	2			1	3	2			2	**10**
Mollusca	Gastropoda	Neotaenioglossa	Pleuroceridae	*Elimia*	2.5	9	13	13	4	7	12	2	2	14	**76**
Mollusca	Gastropoda	Neotaenioglossa	Hydrobiidae	*Antrobia*			1								**1**
Platyhelminthes	Turbellaria	Tricladida	Planariidae	*Dugesia*	7.5		4				1				**5**
Total						**118**	**206**	**39**	**99**	**294**	**225**	**35**	**33**	**127**	